A NEW SPECIES OF *PHASEOLUS* (FABACEAE) FROM WEST-CENTRAL MEXICO

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ABSTRACT

We report the existence of a new species, *Phaseolus albescens*, from western Mexico, with close affinities to *P. vulgaris*, *P. coccineus*, *P. costaricensis*, and particularly to *P. polyanthus*, and describe plants commonly occurring in wild habitats, examine morphological and anatomical characters and give notes on observations made on its floral biology. An illustration of the plant, photographs of its pollen, and stem anatomy are provided. Also, a key to the species of the *Phaseolus vulgaris* group is presented.

RESUMEN

Se reporta la existencia de una nueva especie, *Phaseolus albescens*, del occidente de México, especie afín a *P. vulgaris*, *P. coccineus*, *P. costaricensis*, y en particular a *P. polyanthus* y se describen plantas de esta especie de hábitats silvestres, se examinan caracteres morfológica y anatómicamente y se presentan notas sobre observaciones efectuadas a su biología floral. La especie se ilustra y se provee de figuras de su polen y anatomía del tallo. También, una clave de las especies del grupo *Phaseolus vulgaris* es presentada.

INTRODUCTION

Populations of *Phaseolus albescens* have been recognized as morphologically distinct for a decade (Delgado-Salinas 1988; Ramírez-Delgadillo 1991). Some of the differences were clearly detailed by McVaugh (1987), who treated this species as *Phaseolus*, aff. *P. coccineus* for the Flora Novo-Galiciana. Indeed, McVaugh (1987) recognized *Phaseolus albescens* as different, but not convincingly so from *P. coccineus*. According to him, this plant is easily distinguished from sympatric wild plants of *P. coccineus* by the color of its flowers ["pale-lavender," "old-rose," or "pale rose-pink, fading yellowish"], and by "... less tendency for the flowering axes to be crowded towards the tip." He also compared it with *P. polyanthus* Greenman (also recognized as *P. coccineus*

subsp. *darwinianus* or also as *P. coccineus* subsp. *polyanthus*), stating that this Nueva Galicia plant has shorter, ovate to lanceolate bracteoles and glabrate foliage.

During the course of a phylogenetic study of the genus *Phaseolus*, inferred from molecular data and non-molecular data (Delgado-Salinas et al. unpublished), three collections of *P. albescens* from west-central Mexico were shown to be clearly different from three samples of *P. polyanthus*, one wild collection from Guatemala, one cultivated from Puebla, and one escaped from Perú. *Phaseolus albescens* collections differ from those of *P. polyanthus*, by at least 51 pair-base mutations, 7 of which are transversions, and one deletion of 3 base pairs. In addition to these molecular characters, morphological differences observed during previous studies were shown to be distinguishing. Such characters included the floral bracteoles, flower color, and glabrate foliage. Also the *P. albescens* clade was restricted to a region north of the range of *P. polyanthus*.

In this paper information on the anatomy of the stem and on the floral biology of this species is brought into consideration and thus, the species is described and finally formalized below:

Phaseolus albescens McVaugh ex R. Ramírez & A. Delgado, sp. nov. (**Fig. 1**). *Phaseolus*, aff. *P. coccineus* sensu McVaugh, in McVaugh, Flora Novo-Galiciana 5:654–655. 1987. TYPE: MEXICO. JALISCO: Municipio de Ciudad Guzmán, Naranja Verde-La Retama, a 2 km sobre la deviación que va al Fresnito de la carretera Cd. Guzmán-El Grullo, N 19° 36' 59", O 103° 30' 54.7", 1640 m, 19 Nov 1996, *Delgado et al. 1705* (HOLOTYPE: MEXU; ISOTYPE: IBUG).

Phaseolus polyantho Greenman sylvestri affinis, sed differt bracteolis calycinis brevioribus, floribus lilacinis, postea albescentibus, demum lutescentibus, ovulis 4–5, et distributione geographica in Mexico occidentali.

Perennial herbaceous and woody vine, with secondary growth developed in basal stems, 2–3 cm in diameter, with corky appearance and displaying conspicuous rows of lenticels; root long and lignescent, non-tuberous; stems up to 10 m long, terete, leaning or twining, sparingly branched, covered with sparsely appressed and uncinate hairs. *Leaves* membranous and large, up to 30 cm; *stipules* triangular, ca. 5 mm long, ca. 3 mm wide at base, striate, lately caducous, horizontal to reflexed; *petioles* striate, sparsely strigose, up to 10 cm long, sometimes longer than leaflets, rachis up to 3.5 cm long; stipels ovate to lanceolate, ca. 5 mm long; leaflets entire, terminal ones, ovate to widely ovate, slightly oblique (lateral leaflets) at base, acute or acuminate at apex, apiculate, 8–15 cm long, ca. 10 cm wide, the lateral leaflets sometimes with domatia within its basal veins, sparsely strigose on both surface. *Inflorescences* in axillary pseudoracemes, glabrate or covered with uncinulated or appressed, antrorse hairs, 10–50 cm long, with 10–40 flowering nodes; buds 1–3 in each fascicle, 2 buds commonly flowering; primary bracts nar-

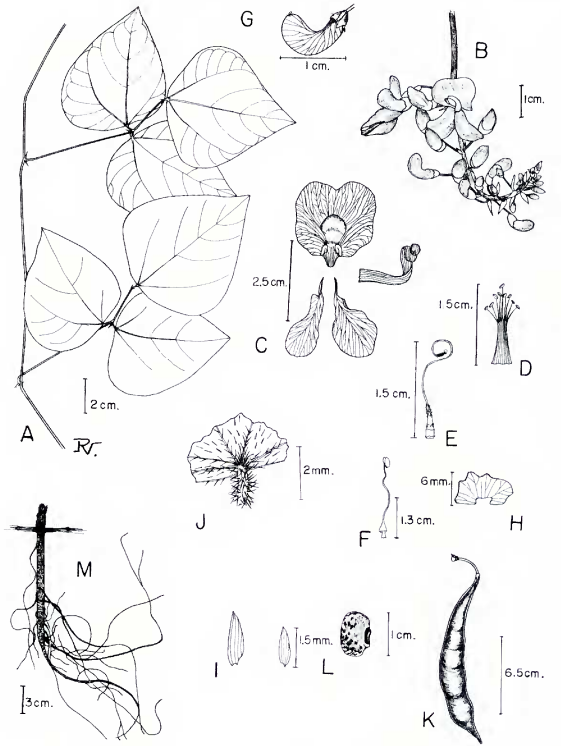


FIG. 1. *Phaseolus albescens* McVaugh ex R. Ramírez & A. Delgado, sp. nov. A. Portion of a branch with leaves. B. Inflorescence drawn from fresh material. C. Corolla (dissected), showing a standard, two wings, and the keel with two tight coils at the apex. D. Androecium. E. Gynoecium. F. Vexillary stamen. G. Flower bud. H, Calyx, dissected. I, Bracts and bracteoles. J. View of the base (amplified) of the terminal leaflet lower surface. K. Pod. L. Seed. M. Root. A–J, *Machuca N. 4708*; K–M, *Ramírez-Delgadillo 2537*.

rowly triangular to lanceolate, striate, persistent, 3–5 mm long, ca. 1 mm wide at base; secondary bracts narrowly triangular, horizontal or reflexed, ca. 2 mm long, 1 mm wide, subpersistent; pedicels thin, thicker at fruiting, 1.5–2 cm long; bracteoles shorter than the calyx, lanceolate, never falcate, slightly auricled at the base, 1–5-nerved, subpersistent, 3–4.5 mm long, ca. 1 mm wide; *flowers* ca. 2 cm long, with *calyx* obliquely campanulate, sometimes with a bulged upper base, tube sparsely strigillose on the outer and the inner surfaces, 5–6 mm long, upper lip emarginate, lower lip with 3 subequal, triangular lobes, ca. 1 mm long; *corolla* lilac fading to white, and later to yellow; standard oblong to orbicular, often little wider than long, 1–1.4 cm long, 0.9–1.2 cm wide, distal portion of outer surface setose, covered with appressed, minute hairs, on the inner surface the lamina shows a thickening at the point of reflexion, the surface between the bending point and the claw covered with micro-papillae, with two swollen appendages at each side of this basal portion, claw ca. 2 mm long; wings obovate, ca. 2 cm long, ca. 1 cm wide, constricted toward the base, upper basal margin round-auriculed with a lamellate surface, claw of wing ca. 5 mm long; keel ca. 1.5 cm long, claws 3 mm long, on distally 1.5 coiled, diameter ca. 3 mm; staminal tube biauriculed towards the base, with sub-basifixed anthers, vexillary or free stamen ca. 1.5 cm long, with a trapezoid-shaped appendage toward the base, its edge undulated; pollen tricolporate, brevicolpate, edge of the colpi reinforced by a margo, ectoaperture membrane granulated, endoaperture (on non-acetolyzed pollen) covered with a smooth operculum; exine with a distinctive sculpturing between the mesocolpium (foveolated-pisilated) and the apocolpium (rugulated)(Figs. 4–5, 8–9); ovaries with 4–5 ovules, strigose, pollen brush short and laterally-placed on the last coil of the style; *stigma* apical, sometimes slightly introrse. *Pods* linear, slightly curved, 7–9 cm long, ca. 1.2 cm wide, short tapered to tapered at base, and with a ca. 1 cm straight beak at the apex; valves chartaceous with narrowly thickened sutures, dehiscent, with a slightly glossy epicarp, light brown-yellowish coloured at maturity, sometimes purple-pigmented, striated, glabrate, (3) 4–5 seeded. *Seeds* 1–1.3 cm long, 7–8 mm wide, ca. 3 mm thick (weight of 100 seed, ca. 20 grams), reniform to sometimes quadrangular, compressed; testa glossy and tan to dark brown mottled and streaked; hilum ovate with a persistent ephilum, ca. 3 mm long, ca. 1.5 mm wide, rim aril prominent, micropylar area lighter than testa color; lens prominent, slightly divided in two. *Seedling* with epigeal germination; epicotyl pubescent; stipules bifid, petiole with basal and apical pulvini (3-portioned); eophylls simple, ovate with a cordate-truncate base, next leaves trifoliolate. Chromosome number, $2n = 22$, in root-tip cells, voucher: *Ramírez-Delgadillo 2553* (IBUG) (P. Mercado-Ruaro, pers. comm.).

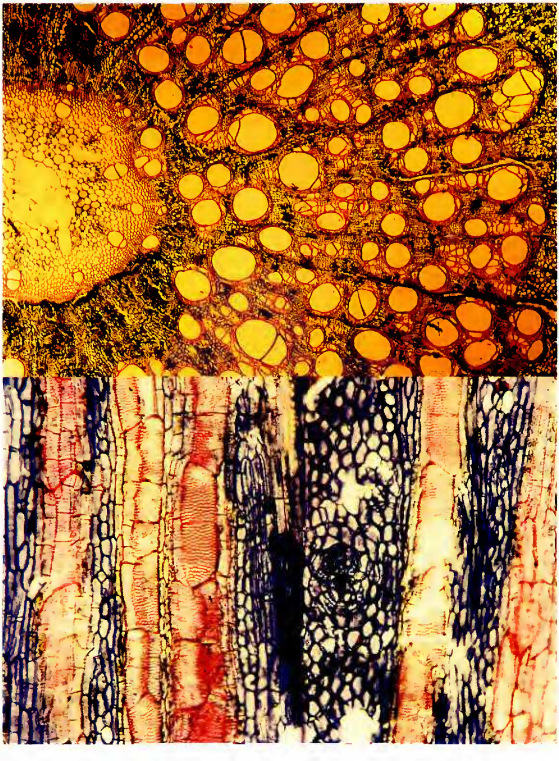
PARATYPES. **MEXICO. Colima:** Municipio de Colima. Rancho El Jabalí, aprox. a 20 km al N de la Cd. de Colima, cerca de la Hacienda San Antonio, 19° 26' N; 103° 40' W, 1,300 m, 7 Feb 1992, *Rico 921 y Martínez* (MEXU). **Guerrero:** Municipio de La Unión, 73 km al NE de Zihuatanejo, carretera Zihuatanejo-Ciudad Altamirano, 1,770 m, 2 Feb 1983, *Tenorio et al. 3237* (MEXU). **Jalisco:** Municipio de Cuautitlán, Sierra de Manantlán, (15–20 mi SE of Autlán) on the bajada south and west of the divide between Aserradero San Miguel and Durazno, 2,000–2,350 m, 6 Nov 1952, *McVaugh 13943* (MEXU; MICH); Arroyo San Miguel, 1.5 km al E de su desembocadura, ca. 1 km al S de Rincón de Manantlán, 19° 35' N; 104° 12' 30 W, Sierra de Manatlán Ocidental, 1,600–1,800 m, 5 Jan 1985, *Judziewicz et al. 5113* (MEXU; WIS); Sierra de Manantlán, en el Rancho El Lamial, carretera para el Rancho de la Jofa, 2,050 m, 10 Dic 1982, *Calzada 9466* y *Nieves* (MEXU;XAL); Municipio de Jocotepec, Barranca del Agua, al N de Zapotitán, 18 Dic 1994, *Machuca N. 4708* (IBUG); *Ramírez-Delgadillo 2553, 3600* (IBUG); Municipio de Tecalitlán, Sierra del Halo, primitive road to San Isidro above the junction SSW of Tecalitlán, 2,000–2,200 m, 20 Nov 1959, *McVaugh & Koelz 1240* (MICH); 20 km SE of JCT with Route 110, on the way to Jalorlán via San Isidro, 2,130 m, 3 Dec 1995, *Kajita et al. 95 120310* (MEXU). **Michoacán:** Municipio de Coalcomán, W of Aguililla, 12 km SE of Aserradero Dos Aguas, 1,600–1,700 m, 27 Nov 1970, *McVaugh 24754* (MEXU; MICH).

Distribution, habitat, and phenology.—*Phaseolus albescens* is restricted to western Mexico, where the genus *Phaseolus* is well-represented (Delgado-Salinas 1985). Sparse populations of *P. albescens* occur mainly in montane forests of the Sierra Madre del Sur (i.e., Sierra de Manantlán and Sierra del Halo). Also on the isolated mountain range known as the Sierra del Madroño, located in the center of the state of Jalisco, with geological links with the Trans-Mexican Volcanic Belt. In Colima, Michoacán, and Guerrero it is distributed on mountains of the Sierra Madre del Sur. The species grows in pine, pine-oak, and deciduous forests, on brown and light-brown clay soils, always in humid and protected environments at 1,300–2,100 m.

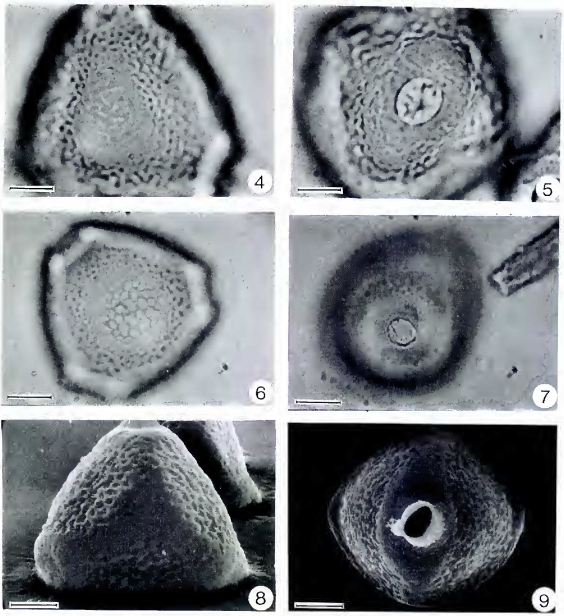
Phaseolus albescens its a late-fall and early winter bloomer (Oct. to Jan.), and sets pods from November to March. In cultivation on the Universidad de Guadalajara grounds, *P. albescens* grew to be a large and vigorous vine, climbing up to ca. 10 meters high. It produced leaves every year and all year around, flowering profusely from October to December, when *Xylocopa* bees were observed visiting its flowers. However, few fruits were set by this plant each year. The plant lived for six years, until a severe drought killed it.

Common name and uses.—While people in Colima are aware of these plants, which they called 'frijolillo', they do not eat them.

Wood anatomy of Phaseolus albescens (Figs. 2–3).—Wood is diffuse porous, with shape of pores oval to angular, in distribution of radial multiples of 2–10 vessels, aggregated in multiples chains or clusters; solitary vessels are of uncommon occurrence. Numerous narrow vessels with 61 pores per mm^2 mixed with the fewer wider vessels with 10 pores per mm^2. Vessel elements are short, with length that ranges from 174 to 192 μm. There is a considerable range of variation, however, in vessel diameter, ranging from a mean



FIGS. 2–3. Anatomical features of the stem of *Phaseolus albescens*. Fig. 2. Cross-section (× 2.5) showing the secondary xylem with a diffuse arrangement of its vessels; also the presence of a sclerenchymatous ring of fibers adjacent to the primary xylem. Fig. 3. Tangential section (× 10) showing radial wood parenchyma composed of homocellular rays, with the presence of nodules (typical of this species), indicated by an arrow. Fibers are located around vessels, excluding the parenchyma cells, which contain abundant polyhedron crystals. Figs. 2–3. *Delgado et al.* 1705.



FIGS. 4–9. Pollen grains of *Phaseolus albescens* and *P. polyanthus*. Figs. 4–5. Light microscopic photographs of *P. albescens*: Fig. 4 showing rugulate ornamentation on the apocolpium. Fig. 5 showing the brevicolpus with a margo surrounding the furtow. Figs. 6–7. Light microscopic photographs of *P. polyanthus*: Fig. 6 showing the finely-reticulated ornamentation on the apocolpium. Fig. 7 showing the short colpus. Figs. 8–9. Scanning electron micrographs of acetolyzed pollen grains of *P. albescens*. Fig. 8 showing at equatorial view one of the three short colpus. Fig. 9. Colpus covered with a finely granulated membrane, and with a slightly lalongate pore, without operculum present due to acetolysis process. Scale bars = 10 µm. Figs. 4–5. *Machuca N. 4708*. Figs. 6–7. *Debouck & Soto 1608*. Figs. 8–9, *Delgado et al. 1705*.

tangential diameter of 42 µm in the narrow vessels to a tangential diameter of 198 µm in the wider vessels. Perforation plates are all simple, the ones from wider vessels elements are predominately transversal, while those of narrower vessels are oblique. Intervessel and vessel-ray pitting is alternate, with minute pits from 5 to 8 µm.

Axial wood parenchyma is abundant and apotracheal, with 2 to 3 cells per segment. Polyhedron crystals frequently forming long chains are abundant in parenchyma cells that surround strands of fibers.

Radial wood parenchyma are composed of scanty homocellular rays, with 3 to 4 rays per mm^2. Ray cells are usually square to upright, where nodules can be observed in tangential section.

The average length of the libriform fibers ranges from 741–1,667 µm (with a mean of 1,310 µm), with a tangential diameter of 25 µm. Fibers are located around vessels, their secondary walls reinforce the wall of the vessels, but also excluding the parenchyma cells.

Pollen description (Figs. 4–9).—Tricolporate, semitectate, spheroidal, P= (40–)51.3(–55) µm length; E= (40–)55(–60) µm width. P:E=1.05. Polar view subcircular, (47.2–)53.3(–60) µm. Exine thickness of 2.4–3 µm. Colpi, brevicolpate, covered with a finely granulated membrane, (19.2–)29.8(–30.4) × (16.8–)21.7(–28.0) µm. Pori slightly lalongate, 5 µm in diameter, the pore is coveted with a conspicuous operculum (non-acetolyzed pollen grains).

Observations on the floral biology of Phaseolus albescens.—Flowers of this species were observed in Jalisco (N 19 36' 59"; W 103 30' 54.7"; 1,640 m) in mid November where high visitation rates were registered, with numerous intrafloral movements made by bees (*Xylocopa guatemalensis*, *Bombus pullatus*, *Bombus* sp., and *Apis mellifera*). Observations occurred between 9:00 am and noon. The color of flowers in this population was lilac fading to white and later to yellow. White flowers were ignored and visits were confined to the lilac-colored flowers, whose standard petal was normally raised and not almost fully reflexed as happens in the white-yellowish ones. The color change (lilac to white) is accompanied by a change in the position of the standard, which the bees probably perceived, so they are able to distinguish between the young and older flowers, apparently there is both an optical and position change to aid the insect in its visit.

Although flowers of a wild plant of *Phaseolus vulgaris* were close-by, no visitation of bees between both species were detected. Also, plants of wild *P. coccineus* were seen growing within two hundred meters, no hybrids between them or with *P. vulgaris* were found.

Relationships with the wild P. polyanthus.—As noted in the introduction, McVaugh (1987) recognized differences between plants corresponding to *Phaseolus albescens* and plants of wild *P. coccineus* and cultivated plants of *P.*

polyanthus. Recently, the wild progenitor of the cultivated *P. polyanthus* has been identified in Gutemala by Schmidt and Debouck (1991), although still not completely described, observations made on its general morphology (*Debouck & Soto 1608*; WIS) and on its seeds (CIAT # 35877) show consistent differences between the two.

Indeed, *P. albescens* is superficially very similar to the wild *P. polyanthus* in fruit, but the number of seeds in the fruit of each taxon differ, mainly having 4–5 seeds in *P. albescens*, while pods with 3–4 seeds are present in the Guatemalan plants. Also the flowers of the two species differ in a number of ways, most noticeably in the form and size of the bracteoles, which in *P. polyanthus* are longer and broadly lanceolate, in addition to the contrasting floral coloration, and change in position of the *P. albescens* standard petal. The pollen of *P. albescens* can be distinguished from *P. polyanthus* by larger dimensions (P:E ratio > 0.13) and foveolate-rugulate exine ornamentation instead of a finely-reticulated one. Furthermore, their actual disjunct distribution (*P. albescens* restricted to west-central Mexico and wild *P. polyanthus* mainly to Guatemala), apparently endures from a fairly old separation from each other in the past. This can be assumed comparatively by the number of molecular changes presented by *P. albescens* different from the cultivated and wild *P. polyanthus*.

The specific epithet '*albescens*' refers to the flower color of this species being lilac at anthesis, then turn in, white and later yellow when older.

KEY TO *PHASEOLUS ALBESCENS* AND WILD RELATIVES

1. Inflorescences few-flowered, commonly with 8 or less flowering nodes; flowers small to medium size, standard-petal 1 cm or less long; pods narrow, ca. 1 cm wide; seedlings with epigeal germination.
   2. Pedicels in flower 3–7 mm long; bracteoles linear-ovate to lanceolate, shorter than calyx, less than 1 mm wide, 1–3 veined; petioles of first seedling leaves (eophylls) subsessile ..... **P. acutifolius** A. Gray
   2. Pedicels in flower 0.5–1.2 cm long; bracteoles broadly ovate, prominent, equaling the calyx, 2.5–4 mm wide, 5–10 veined; petioles of first seedling leaves (eophylls) elongated, not sessile ..... **P. vulgaris** L.
1. Inflorescences many-flowered, commonly with 10–30 flowering nodes; flowers medium to large size, standard-petal more than 1 cm long; pods broader, more than 1 cm wide; seedlings with epigeal or hypogeal germination.
   3. Plants developing of a thick, often branched, tuberous root; corolla commonly red, rarely purple or white; stigma apical-extrorse; seedlings with hypogeal germination ..... **P. coccineus** L.
   3. Plants not developing of a tuberous root, main root lignified or fibrous; corolla dark pink, purplish, lilac or white; stigma terminal or introrse; seedlings with epigeal germination.
      4. Corollas dark pink or lilac to purple, wing-blades at anthesis not fully expanded, clasping; bracteoles broad, 2.5–8 mm wide; plants from Costa Rica and Panamá ..... **P costaricensis** Freytag & Debouck

4. Corollas lilac-white or white, wing-blades at anthesis fully expanded; bracteoles narrower, 1–1.5 mm wide; plants from western México and Guatemala.
5. Bracteoles broadly lanceolate, sometimes falcate, commonly exceeding the calyx, 6–8 mm long; pods with 3–4 seeds ..... **P. polyanthus** Greenman
5. Bracteoles lanceolate, never falcate, shorter than calyx, 3–4.5 mm long; pods with 4–5 seeds. ..... **Phaseolus albescens** McVaugh ex R. Ramírez & A. Delgado

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